"THE EFFECT OF RIGHT SIDE MEDIAN NERVE STIMULATION ALONG WITH STRUCTURED MULTI SENSORY COMA STIMULATION PROGRAM ON LEVEL OF CONSCIOUSNESS AND NEUROBEHAVIORAL FUNCTIONS AMONG DIFFUSE AXONAL INJURY PATIENTS"

AN EXPERIMENTAL STUDY

Dissertation submitted to the Tamilnadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of MASTER OF PHYSIOTHERAPY (Advanced PT in Neurology)) degree Programme.

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Certificate

CERTIFICATE

This is to certify that research work entitled **"THE EFFECT OF RIGHT SIDE MEDIAN NERVE STIMULATION ALONG WITH STRUCTURED MULTI SENSORY COMA STIMULATION PROGRAM ON LEVEL OF CONSCIOUSNESS AND NEUROBEHAVIORAL FUNCTIONS AMONG DIFFUSE AXONAL INJURY PATIENTS"** was carried out by the candidate bearing the Register No: **27101607**, KMCH College of Physiotherapy towards partial fulfillment of the requirements of the **Master of Physiotherapy (Advanced PT in Neurology)** degree course under The Tamil Nadu Dr. M.G.R. Medical University, Chennai-32

PROJECT GUIDE

Mrs.A. BRAMMATHA, M.P.T, (Neuro)
Professor,
KMCH College of Physiotherapy
Coimbatore- 641014

PRINCIPAL

Dr. EDMUND M. D'COUTO,
MBBS.Dip.Phy.Med & Rehab
KMCH College of Physiotherapy
Coimbatore- 641014

INTERNAL EXAMINER

EXTERNAL EXAMINER

Project Evaluated on:

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Abstract

ABSTRACT

OBJECTIVE: The aim of the study is to find the effects of right side median nerve stimulation along with structured multi sensory coma stimulation program on level of consciousness and neurobehavioral function among diffuse axonal injury patients. **STUDY DESIGN:** Pre-test and post-test experimental study design. **PARTICIPANTS:** 9 male diffuse axonal injury patients were selected and randomly assigned into experimental group and control group. **INTERVENTIONS:** Patients in the experimental group received right side median nerve stimulation along with multistructural sensory stimulation for 2 hours and the control group patients received multistructural sensory stimulation along with sham stimulation for 2 hours. Both the group were treated for 2 weeks duration. **OUTCOME MEASURES:** Neuro behavioural function was assessed with western neuro sensory stimulation profile and level of consciousness was assessed by Glasgow coma scale at baseline and after two weeks of study. **RESULTS:** After 2 weeks duration there was a significant improvement in level of consciousness between the groups but there was no significant improvement in neurobehavioral function between the groups. **CONCLUSION:** The results showed that there was significant improvement in Level of Consciousness between the groups but there was no significant improvement in the Neurobehavioral Functions between the groups.

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Introduction

INTRODUCTION

A Traumatic Brain Injury (TBI) is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. Not all blows or jolts to the head result in a Traumatic Brain Injury. The severity of a Traumatic Brain Injury may range from "mild," i.e., a brief change in mental status or consciousness to "severe," i.e., an extended period of unconsciousness or amnesia after the injury. The majority of Traumatic Brain Injury that occurs each year is concussions or other forms of mild Traumatic Brain Injury.[16]

The Centers for Disease Control and Prevention (CDC) defines Traumatic Brain Injury as "craniocerebral trauma associated with neurological or neuropsychological abnormalities, skull fracture, intracranial lesions or death"[8].

Traumatic brain injuries are a leading cause of morbidity, mortality, disability and socioeconomic losses in India and other developing countries. It is estimated that nearly 1.5 to 2 million persons are injured and 1 million succumb to death every year in India. Road traffic injuries are the leading cause (60%) of TBIs followed by falls (20%-25%) and violence (10%). Alcohol involvement is known to be present among 15%-20% of TBIs at the time of injury[74].

Traumatic brain injury is twofold times higher in males when compared to females. It is usually caused by a dynamic loading or impact to the head from direct blows or sudden movements produced by impacts to other body parts. This loading may be compression, expansion, acceleration, deceleration, and rotation of the brain inside the skull. The type of damage is directly related to the cause and severity of the injury. Brain injury may be focal or diffuse or both. Motor vehicle accidents and falls involve acceleration and deceleration with rotation of the brain inside the skull. The brain stem is more stable then cerebrum, which rotate around the brain stem during impact. The rotation places a stretch or shear force on the long axons that transmit information throughout the brain and brainstem. These injuries are termed diffuse axonal injuries (DAI) and result in coma because of the damage to the axons in the midbrain reticular activating system[7].

DIFFUSE AXONAL INJURY

It is characterized by wide spread shearing and retraction of damaged axons. Axonal changes eventually lead to their separation from the soma. Diffuse axonal injury may be severe enough to cause coma and correlates with less clinical recovery[55].

COMA

A state of profound unconsciousness in which an individual is incapable of sensing or responding to external stimuli. According to Plum and Posner in the comatose stage, the person cannot be aroused by sensory stimulation, has his eyes closed, and demonstrates an absence of observable interaction with the environment[42].

This comatose stage is often seen in critically ill brain-injured patients .Coma occurs from a variety of local or diffuses injuries that disrupt the Reticular Activating System (RAS) of the brainstem. Arousal, the foundational element of information processing, is maintained by the Reticular Activating System. Coma results whenever there is a loss of communication from the Reticular Activating System into the cerebral hemisphere. This is called a vegetative state and for a person in this state the deep brainstem functios such as breathing, reflex and heart rate are intact but there is complete impairment of cortex. With the depression of cerebral activity the person cannot be aroused.

Arousal is very much important because it is the physiological readiness of the human system for activity. The various levels include alert, lethargic, delirium, obtunded, stupor, and coma[55]. Arousal is prerequisite for the selective attention which is necessary for recognizing and processing information. Without arousal, more complex cognitive processes, such as sustained attention or concentration necessary for learning, cannot occur (Arciniegas et al)[4].

With the advancement in the modern medical era and with the availability of good emergency health care the number of patients surviving the traumatic brain injuries have increased, research had focused on finding factors that predict the outcome of such injuries. The reasoning is that if outcome can be predicted early in coma, extensive medical

treatment and rehabilitation could be directed to patients who had the best chance of survival with fewer residual impairments. And in a study it has been found that patients under 45 years of age in coma stage shown good prognosis following therapy than older patients.

After traumatic brain injury, patients in coma for greater than 1 week and aged 45 years or younger have a potential for good recovery and gains in function continue for years after the injury. The rehabilitation needs of brain injured persons are significantly high and increasing from year to year[35].

COMA STIMULATION

Wood stated that Coma recovery programs aim to provide multi sensory stimulation to patients in coma or vegetative state. It is hoped that with intense and repetitive stimulation, the patient will awaken and return to a higher level of functioning[70]. Coma arousal therapy is believed to provide the sensory stimulation needed to activate the reticular system, which is responsible for maintaining consciousness. These procedures are appropriate for any individual who is in coma or vegetative state and is medically stable. It involves repetitive tactile, auditory, visual, taste, proprioception, and olfactory stimulation. Sensory stimulation is seen as a means to increase awareness to maintain " cortical tone" which is known as vigilance. It is also knows as **coma arousal therapy**, **sensory stimulation**, and **coma care**[7].

Cope and Hall et al determined that early rehabilitation after brain injury produced better outcomes. It can be argued that early environmental stimuli via sensory stimulation program enhances the recovery mechanism activation immediately following brain injury and aids in the recovering processes such as plasticity, which is demonstrated as increased arousal in comatose patients[11]. Sensory deprivation following traumatic brain injury in unconscious patients can be prevented by, sensory stimulation program (SSP) which should be started in the early stage of injury (Mitchell, Bradley)[38].

MEDIAN NERVE STIMULATION:

Median nerve stimulation brings numerous afferent inputs to the Ascending Reticular Activating System (ARAS) via the spinoreticular component of the median nerve synapsing with the neurons of the Ascending Reticular Activating System. Therefore, another means to maintain wakefulness exists. The median nerve serves as a peripheral gateway (window) to the central nervous system. This is reflected in the fact that the sensory distribution of the hand has a large cortical representation in the brain. Median nerve stimulation seems to activate the entire central nervous system. It is proposed that this peripheral stimulus goes to the Ascending Reticular Activating System, which further connects with the intra laminar nuclei of the thalamus and then stimulates the cortical layers[10].

The median nerve of the right arm was chosen as the way to deliver stimulation for several reasons. The hand is controlled by quite a large portion of the brain. So, by using the arm, we can reach a major part of the brain. In addition, the nerve of the right arm leads into the left side of the brain, where most people control their speech and language. An in a study it was found that there is a better pattern of speech and abilities to calculate observed after right median nerve electrical stimulation (RMNS). **(Cooper & Cooper Jane, Alves, & Cooper)**[10,22]**.**

In the majority of individuals, whether right handed or left handed, Broca's motor/speech planning area is in the left frontotemporal region. Broca's area has been shown to become more active in Positron Emission Tomography (PET) when a subject moves his/her hand, or even contemplates speaking or moving the hand. This process is also artificially driven by RMNS (**Cooper & Cooper; Spiegel**)[10].

Recent studies demonstrate various effects of right median nerve electrical stimulation (RMNS). They are

• Increases cerebral blood flow – measured by Single Photon Emission Computerized Tomography scans and Magnetic Resonance Imaging

• Hastens awakening from coma

• Improves speech

• Increases cerebral activity

• Facilitates neural responses in damaged cortex

• Improves vigilance, motor and emotional responses, and

• Elevates cerebral spinal fluid catecholamine (especially dopamine, which is involved in maintenance of consciousness and motor control).

The practical implication of sensory deprivation is that controlled stimulation (consisting of auditory, gustatory, olfactory, tactile, kinesthetic, and visual modes) may meet the higher threshold of the reticular neurons and increase cortical activity or that the undamaged axons may actually send out collateral connections, called collateral spouting, which assist in reorganizing the brain's activity **(Sosnowski & Ustik)**[51]. **Wood** recommended a sensory regulation modal , in which there is a quiet environment, rest periods, and carefully regulated intensity, frequency and duration of stimulus presentation to increase vigilance.[69]

Nerve cells called neurons carry signals through the brain stem and up to the thalamus - that part of the brain that controls breathing. It may also increase cerebral blood flow. From the thalamus signals then passes to the cerebral cortex which controls cognitive function - the ability to sense, feel and interpret the environment. Signals from the Median Nerve Stimulation may stimulate the growth of new axons (long nerve fibers) that transmit messages between nerve cells. These new nerve fibers may develop bridges reaching out to damaged areas of the cerebral cortex helping the brain to re-wire itself[10,69].

E. B. Cooper et al concluded that electrical stimulation of the right median nerve in a sluggish opposition of thumb and index finger is the cause for the response of patients after one or two weeks in which they are able to follow or understand first simple command. This purposeful right hand response while the brain injured patient still appears to be semi-comatose, demonstrates that the five million electrical pulses delivered to the nervous system in the first 10 days of treatment have been copied and stored in the hard drive of the brain[10].

1.1 NEED FOR THE STUDY:

Unconscious patients after brain injury may survive for days or months and often experience decreased quality of life. To facilitate the recovery process and to prevent sensory deprivation after brain injury, sensory stimulation program (SSP) beginning in the early stages of recovery can be beneficial.

There were two pilot studies at the University of Virginia (1994-1995 and 1998-1999). In both studies comatose trauma patients were randomly assigned into electrical treatment or sham treatment groups. The neurobehavioral rates were blinded to the treatment conditions. There were six patients in the first study and 10 patients in the second study, in the earlier study the electrical group had a shorter time in the intensive care unit (**Cooper et al.,**)[10]. In the second study the electrical treated comatose patients had a shorter time of endotracheal intubation (**Peri et al.,**)[9]. Coma stimulation prevents the individual from progressing into vegetative state which act the recovery of the individual. Early rehabilitation will improve the consciousness and prevent the complications.

Previous studies have also found that sensory stimulation of sufficient frequency, intensity and duration was shown to arouse the brain by improving neuronal organization, increased dendritic branching, increased numbers of dendritic spines; stimulating the reticular activating system(**Ansell et al; DeYoung & Grass; Kater**)[1,13,26]; and level of cognitive function**.** Maximum reorganization of the brain occurred within the first few weeks after brain injury **(Larkin et al.,)**[29]. Delayed recovery from coma stage may predispose patients to various morbidities such as pressure ulcer, muscle wasting, pneumonia, and so forth (**Cope &Hall et al,**)[11].Early intervention to enhance consciousness recovery is mandatory to minimize these morbidities.

Most of the previous studies regarding right median nerve stimulation were single case study, series case study or a pilot study and only a very few studies on randomized controlled trial in coma stimulation for head injury patients is available in the literature. Till now there is not much importance have been given for right median nerve stimulation for coma patients in our hospital setup. And there are also conflicts going on regarding the effectiveness of right median nerve stimulation in acute coma patients.

Cooper et al,[10] stated that the duration of the treatment can be 6 to 8 hours. But in our setup it is not possible because of the low economic status of the patients and long term follow up cannot be seen here because the patient got discharged once they are medically stable at their own willingness and there is also a poor follow up after discharge from the hospital. So I have chosen the treatment duration as 1 hour which is also combined with structured multi sensory coma stimulation program for two weeks.

Most of the studies in the past have only studied the effects of median nerve stimulation and coma stimulation as separate entities. So far it is the first study which combined right side median nerve stimulation and structured multi sensory coma stimulation for two weeks and it aims to find out its effectiveness on the level of consciousness and neurobehavioral function.

Review of literature

1. REVIEW OF LITERATURE

2.1 DIFFUSE AXONAL INJURY:

- **Sung Jun Park., (2009**) They concluded that MRI had shown that recovery of consciousness in patients with diffuse axonal injuries and the degrees of brain injuries. Patients with diffuse axonal injuries with small hemorrhagic lesions on the hemispheric white matter or corpus callosum recovered consciousness within 2 weeks. In contrast, patients with additional lesions on the brain stem did not recover consciousness within 2 months[54].

2.2 MULTI SENSORY COMA STIMULATION:

- **Steffany Chlebain et al,.(2009),** In a ABA style case study design, the changes in responsiveness after hearing different voices by brain injury survivors with impaired consciousness has been noted. The patients received auditory stimuli with familiar and synthetic voice massages. In that about 2 patients had a good responsiveness after the auditory stimulation. Others didn't show any change. And the findings concluded that auditory stimulus arouse the brain responsiveness in unconscious head injury patients[52].

- **Pornnipa et al**., (**2009)** In a quasi experimental study the effect on sensory stimulation program on recovery in unconscious patient was examined, group were divided into experimental and control group. In the sensory stimulation program included (tactile, visual , auditory , gustatory and olfactory sense) were taken. GCS were taken as a outcome measure .Results show that SSP was significant effect in the experimental group than the control group[43].

- **Vijaya muniraj et al(2008)** the effectiveness of coma stimulation therapy in a closed head injury was seen through the somatosensory evoked potential. Glasgow coma scale and coma/near coma scale was used and compared. It is a single case experimental study design In the coma stimulation therapy tactile,visual,olfactory,gustatory, kinesthetic and auditory stimulation was done. In the somatosensory , central conduction time was noted at the initial and after 4 weeks of

treatment .the improvement has been noted in the central conduction time and coma/near coma scale, Glasgow coma scale after the stimulation. The study concluded that coma stimulation therapy is effective on the closed head injury comatose patients[63].

- **Viona J. M. Wijinen et al., (2006),** To examine the effect of sensory stimulation on automatic reactivity in severe traumatic brain injury patients, a study has been conducted. Skin conductivity and heart rate reactivity has been noted in response to the sensory stimulation. The level of consciousness, cognition and functional behaviour are also assessed along with that both the skin conductance and heart rate variability are changed during the sensory stimulation. Hence the study results concluded that sensory stimulation has effects on autonomic reactivity.

- **H. J. Eilander et al.,(2005),** In a one group pre test – post test study design, the outcome of early intensive neurorehabilitation programme was noted. In this study, the inclusion criteria were children and young aduluts who are prolonged unconscious state; having severe head injury. Total number of patients is 145. The outcomes are level of consciousness. The early intensive neuro rehabilitation program includes sensory stimulation also. The study duration was 2 months. The result shows that 2/3rd of patient's attained full consciousness. The loss of consciousness has been improved after the treatment duration[64].

- **Alice E. Davis et al., (2003)** He concluded "The effects of voices and other auditory stimuli have been examined with respect to changes in cerebrodynamic and cardiopulmonary status". An issue related to safety is the cerebral hemodynamic and cardiopulmonary responses during sensory stimulation. In this study, auditory stimulation was not found to affect ICP, HR, RR, or MAP[13].

- **Mazoux et al., (2001)** Efficacy of early rehabilitation to improve the motor and functional recovery and also to prevent the secondary complications .totallt 876 patients has been taken, the duration of treatment is one year, sensory stimulation was given to the patients, GCS scale was the outcome measure, results show that there is a significant improve the arousal & also prevent the secondary complication in the acute rehabilitation when compare to late rehabilitation[37].

- **Sara et al.,(1997)** In a review of literature showing the effect of multimodal & unimodal stimulation coma stimulation about 10 studies has been taken. Among the four studies there is improvement taken in multimodal stimulation. two studies there is no significant improvement in the behaviour change & mean responsiveness. Among three studies in the unimodal treatment , and one shows there is no significant and two shows is change in the behaviour[46].

- **Sarah L Wilson** (**1993)** In the seven single case studies, about four of the patients showed behavioural changes with the multimodal stimulation and others three patients showed who underwent unimodal stimulation treatment also showed significant behavioural changes[68].

- **Lise R.talbot et al**.,**(1994**) in a single case study to determine the alter state of consciousness in severe head injury patients, the age group has been taken from 19 to 55, structured intervention included (visual, auditory, gustatory & tactile stimulation), GCS scale was the outcome measure . Results shows that improvement in the auditory & visual skills performance, manual performance, swallowing am language in the first 24 months following severe head injury[34].

- **Sarah L Wilson et al.,** (**1992**) in a four single case experimental design including four pilot studies, the effect of music stimulation in prolonged coma was examined. The results show that two studies show a significant improvement in behavioural changes. Mainly the arousal, another one shows a reduction in the arousal and the last study shows no behavioural changes[47].

- **Mary E. Hall et al., (1992**) to examine the effect of directed multisensory stimulation with non-directed stimulation, a pilot study was conducted on six closed head injury patients. Both the treatments are given to the patients in alternative weeks of structured directed stimulation. The non-directed stimulation was given for half an hour per day. If the patient is on tracheostomy, olfactory stimulation was not provided .The scales used are GCS, WNSSP. In which GCS shows an average improvement of scoring 4 to scoring 14 at the end of the treatment. the WNSSP shows a general improvement, but especially on the auditory, tactile and visual comprehensive scales, from this study concluded that directed multisensory stimulation is effective than the non- directed stimulation[36].

- **Sarah L Wilson et al., (1991)** the effect of sensory stimulation on four prolonged coma patients was examined. The behavioural measures were taken before and after the stimulation, which has compared later. And the results show that there is a significant behavioural change especially increased arousal after stimulation[65].

- **Ansell et al., (1991)**, they studies conducted on an animal modal , sensory stimulation of sufficient frequency , intensity , and duration was shown to arouse the brain by improving neuronal organization, increased dendritic branching, increased number of dendritic spine ; stimulating the reticular activating system[3].
- **Sisson et al., (1990)** in a pilot study, about of 5 comatose patients were included to determine the effect of auditory stimuli. Cortical activity was recorded by EEG. With the auditory stimulation, these comatose patients given response and about two patients have response eye opening and movement of extremities. By this we came to know that there is a response for the auditory stimulus in closed head injury comatose patients[50].

- **Sylvia Mitchell et al., (1990)** in an experimental study design, the experimental group receives "coma arousal procedure" by using coma kit by their relatives and the control group receives no treatment at all. About 12 patients was included the duration was 2 hours daily. The results concluded that the coma arousal procedure total duration was shorter but the coma gets lightened for the experimental group[38].

- **Rader et al., (1989)**, to know the effect of sensory stimulation of severe brain injured patients, 3 single case series was reported. In the first , the results shows that there is behavioural changes immediately after the sensory stimulation, which can change due to positioning and the behavioural changes can be measured. In a second study, there is a good reliability and validity for the RLA scale. In third study reveals there is no significance in the mean general responsiveness secondary to the sensory stimulation[44].

- **Cope & hall et al., (1982)** they suggested that early rehabilitation after brain injury produced better outcomes. With the current state of knowledge related to activation of recovery mechanisms immediately following brain injury, it can be argued that early environmental stimuli via a sensory stimulation program may enhance recovery

processes such as plasticity, which is demonstrated as increased arousal in comatose patients[11].

- **Bahadarkhan et al.,** in a perspective , double blind study, the effect of tactile, visual and auditory stimulus on the vegetative parameter changes in 22 comatose patients has been examined, two groups namely experimental and control group has been taken. GCS scale was the outcome measure. The results concluded that there is a significant improvement in the GCS scale after the tactile, thermal, visual and auditory stimuli.

2.3 RIGHT MEDIAN NERVE STIMULATION:

- **Christian V. Peri et al., (2001),** in a double blind randomized controlled study, the benefits of electrical stimulation on median nerve was assessed. The patients were having severe brain injuries. Total number of samples is 10. In that six were allocated in experimental group who received 300 ms intermittent pulses at 40 hz, 15 – 20 mA 8 hours per day till 14 days. The remaining 4 patients were allocated to control group which received sham treatment. Glasgow Coma Scale was chosen as the outcome measure. The study concluded that the experimental group received mean 2 days from coma than control group but the result was not statistically significant. There has been a improvement in Glasgow Coma Scale in the experimental group[9].

- **Katsuyasu et al., (1999**) in a single case study , the effect of median nerve stimulation on a persistant vegetative state patient has been noted. During the time of admission Glasgow coma scale was 4. CSF concentrations of the neurotransmitter dopamine and GABA was noted before and after the treatment. The duration duration was 3 weeks. Immediately after treatment duration there has been a rise in the response of dopamine and GABA, which shows that median nerve stimulation arose some therapeutic mechanism in the persistent vegetative state[27].

- **J. Bryan Cooper et al., (1998),** the effects of stimulation right median nerve to hasten awakening from coma was studied. It is a double blinded pilot study. The outcome scale used was Glasgow Coma Scale. The treatment duration was 2 weeks. The patient received 12 hours of stimulation. The study concluded that electrical stimulation is having a positive effect on coma, hastens awakening and cost effective[5].

- **Takaski Moriya et al.,(1998),** in a study conducted to see the usefulness of median nerve stimulation on Crebrospinal fluid Dopamine changes. About 24 patients has been taken. Glasgow Coma Scale was also one of the outcome measure. It is a double blinded experimental study design for 2 weeks. The results shown that median nerve stimulation has been elevated the cerebrospinal fluid Dopamine concentration and the clinical symptom on comatose patients will have the improvements[39].

2.4 GLASGOW COMA SCALE:

- **Teasdale et al., (1974**) they found that GCS is the most widely used and validated tool to evaluate the state of consciousness[61].

- **B S Liew et al., (2009)** they utilized GCS as a measurement tool that assess the level of consciousness in diffuse axonal injury patients[6].

2.5 WESTERN NEURO SENSORY STIMULATION PROFILE

- **Vanessa et al (2001)** to identify the effect the cognitive sensory recovery pattern in 25 traumatic head injury patients with minimal conscious state, this scale shows good concurrent validity with the Rancho scale- II, results show that object manipulation was an early emerging skill and also observed in auditory response, visual tracking and olfactory response[62].

- **Ansell et al(1993)** they found that visual tract response was more predictable value in the traumatic head injury patients[1].

- **Taldot et al (1998)** western neuro sensory profile scale to assess the neurobehavioural changes , they found that visual response and attention are important predictors of rehabilitation[60].

- **Whitaker et al (1994)** this profile was to assess the minimal conscious patient, auditory and visual response as early emerging behaviour in the minimally conscious patients[59].

Aim and objectives

3 AIM AND OBJECTIVES

3.1 AIM

The aim of the study is to compare the combined effects of right side median nerve stimulation along with structured multi sensory coma stimulation program versus structured multi sensory coma stimulation program along with sham stimulation on the level of consciousness and neurobehavioral function among individuals with diffuse axonal injury.

3.2 OBJECTIVES

- To find out the effect of structured multi sensory coma stimulation program along with right side median nerve stimulation on neurobehavioral function and level of consciousness among diffuse axonal injury patients.

- To find out the effect of structured multi sensory coma stimulation program along with sham stimulation on neurobehavioral function and level of consciousness among diffuse axonal injury patients.

- To compare the effect of structured multi sensory coma stimulation program along with right side median nerve stimulation program and structured multi sensory coma stimulation program along with sham stimulation on level of consciousness among diffuse axonal injury patients.

- To compare the effect of structured multi sensory coma stimulation program along with right side median nerve stimulation program and structured multi sensory coma stimulation program along with sham stimulation on neurobehavioral functions among diffuse axonal injury patients.

Materials and methodology

4 .MATERIALS AND METHODOLOGY

4.1 STUDY DESIGN:

- Pre and post test experimental study design

4.2 SAMPLING TECHNIQUE:

- Purposive sampling

4.3 SAMPLE SIZE:

- A total of 9 subjects with 4 in control group and 5 in experimental group

4.4 STUDY SETTING:

- Neuro intensive care unit and ward, KMCH hospital, Coimbatore.

4.5 CRITERIA FOR SELECTION:

4.5.1 INCLUSION CRITERIA:

- Age between 18 to 45 years
- Patient with stable vital signs, central venous pressure, and intracranial pressure (ICP) for 24 hours before the enrollment
- The Glasgow Coma Scale (GCS) score between (2T, 3 and 8)
- Diffuse axonal injury patient (diagnosed by neurologist)
- Left dominant hemisphere patient (as told by caregivers – right handed)

4.5.2 EXCLUSION CRITERIA:

- Brain injury – traumatic open injury, endocrine dysfunction, metabolic coma, epilepsy hepatic coma, uremic coma
- History of Visual dysfunction - blindness , color blindness
- History of Auditory dysfunction - deafness, hearing loss

- Presence of brain stem injury or infarction, which was confirmed by imaging studies
- History of Congenital heart disease / valvular dysfunction / unstable angina & cardiomyopathy, pulmonary dysfunction
- Patients with implanted pacemakers or defibrillators
- Pregnancy
- Alcohol and/or drug intoxication

4.6 HYPOTHESIS

4.6.1 NULL HYPOTHESIS

H_{01} There is no significant effect of right side median nerve stimulation along with structured multi sensory coma stimulation program on level of consciousness and neurobehavioral function among diffuse axonal injury patients.

H_{02} There is no significant effect of structured multi sensory coma stimulation program and sham stimulation on level of consciousness and neurobehavioral function among diffuse axonal injury patient.

H_{03} There is no significant difference between structured multi sensory coma stimulation program along with right side median nerve stimulation versus structured multi sensory coma stimulation program along with sham stimulation among diffuse axonal injury patients.

4.6.2 ALTERNATIVE HYPOTHESIS

H_{a1} There is a significant effect of right side median nerve stimulation along with multistructual sensory stimulation program on level of consciousness and neurobehavioral functions among diffuse axonal injury patients.

H_{a2} There is a significant effect of structured multi sensory coma stimulation program and sham stimulation on level of consciousness and neurobehavioral function among diffuse axonal injury patient.

H_{a3} There is a significant difference between multistructurtal sensory stimulation program along with right side median nerve stimulation versus multistructurtal sensory stimulation program along with sham stimulation therapy in diffuse axonal injury patients.

4.7 PROCEDURE:

Prior formal permission and approval for the study was obtained from the neuro physician. Informed consent was obtained from the patient care givers or relatives. Totally 9 patients from whom the informed consent was obtained and also fulfilled the study criteria were selected by purposive sampling technique. Out of these 9 patients 5 subjects were assigned to experimental group and 4 subjects were assigned to control group in a alternate manner. Control group consisted of Diffuse Axonal Injury patients and they received the multi sensory coma stimulation therapy along with sham stimulation. Experimental group consisted of Diffuse Axonal Injury patients and they received the multi sensory coma stimulation therapy along with right side median nerve stimulation.

Before the start of the treatment procedure the information about the duration of coma was collected for both the groups. pre-test score for level of consciousness was assessed using Glasgow Coma Scale, and neurobehavioral function was assessed using Western Neuro Sensory Stimulation Profile scale.

4.7.1 CONTROL GROUP:

Subjects in control group receive structured multi sensory coma stimulation therapy along with sham stimulation therapy.

STRUCTURED MULTI SENSORY COMA STIMULATION THERAPY:

The following stimulation has been given in this program which includes

1. Visual
2. Auditory

3. Tactile
4. Proprioception

SHAM STIMULATION:

In this treatment protocol the patient was positioned in supine lying and active electrode was placed over the right side lower one third of forearm on the volar aspect and passive electrode was placed on the right side middle one third of forearm on the volar aspect and the intensity was not raised.

4.7.2 EXPERIMENTAL GROUP:

Subjects in experimental group receive right side median nerve stimulation along with structured multi sensory coma stimulation therapy.

STRUCTURED MULTI SENSORY COMA STIMULATION THERAPY:

The following stimulation has been given in this program which includes

1. Visual
2. Auditory
3. Tactile
4. Proprioception

RIGHT SIDE MEDIAN NERVE STIMULATION:

PARAMETERS:

- Type of current: faradic current
- Wave form: asymmetrical biphasic
- Pulse duration: 300 ms
- Pulse frequency: 40 Hz
- Pulse amplitude: sufficient enough to achieve desired, strength of contraction.

- No of contraction: based on the response of the muscle in order to avoid fatigue
- On time : 20 sec/ min
- Off time : 40 sec/ min
- Active electrode : = volar aspect of right side forearm
- Inactive electrode : = volar aspect of lower 2/3 of right side forearm
- Duration : 1 hours/day

The skin was checked for erythema and burns under electrode site after each treatment sessions.

Fig., 1.a showing the electrical stimulator used in this study

STRUCTURED MULTI SENSORY COMA STIMULATION PROTOCOL:

SENSORY STIMULATION

- **FUNCTION: Visual**

  - **Type:**
    - Bright light
    - Colorful cards,
    - Familiar objects,
    - Family photographs (labeled)
    - Mirror
  - **Method:**
    - Bright light On/off for 1 sec for 10 sec.
    - Hold a hand mirror 4-6 inches directly in front of the patient's face and verbally encourage the patient to fixate on the mirror.
    - Move mirror slowly 45 degrees to the right and left of the Vertical midline and 45 degrees above and below the horizontal midline.
    - Present a brightly colored or illuminated object 6 to 8 inches in front of the patient's face and then rapidly move to upper, lower, right and left visual fields.
    - Present visual threat by passing finger 1 inch in front of patient's eye. Be careful not to touch eyelashes or create a breeze(manually open eyes if necessary).
  - **Duration:** 2 minutes for each item with a total duration of 5 minutes
  - **Method of evaluation:**
    - Pupillary reaction
    - Initiation of eye blink or movement of head.
  - **Response:**
    - Recognizes written/pictorial images

- Pupil dilated with no response to light
- Pupils constrict appropriately to light
- Eyes track moving object
- Perceives color and light

➢ **FUNCTION: Auditory**

❖ **Type:**

- Simple, loud sound to ear
- Use radio, tape recording of a familiar voice for 5 minutes
- e.g. call the patient's name,
- clap your hands,
- ring a bell,

❖ **Method:**

- Standing behind the patient and out of view, present an
- auditory stimulus (eg. voice, noise) from the right side for 5
- seconds and left side for 5 seconds
- Clap 2 pieces metal or wood next to L ear, R ear

❖ **Duration:** On/off for 1 sec for 10 sec, 5-10 sec for each item with a total duration of 5 minutes

❖ **Method of evaluation:**

- Patient initiates blink or head turning briskly upon auditory stimulation or startle reflex

❖ **Response:**

- No reaction to loud stimulus
- Patient startles appropriately to loud stimulus
- Turns head to voice
- Follows commands.

➢ **FUNCTION**: **Olfactory**

- **Type**
  - Use cologne, favored extracts, coffee grinds, shampoo, and favorite foods, banana.
  - Provide the stimuli for 10 seconds.
  - Use garlic and mustard as noxious stimuli.
- **Method:** the stimulus through each nostril
- **Duration:** 5 minutes
- **Method of evaluation**
  - Tearing, facial flush, breath holding, withdrawal
- **Response:**
  - No reaction to stimules
  - Nose twitching, tearing, flushing of face with stimules
  - Turning of head away from stimulus

➢ **FUNCTION: Taste**

- **Type:** Tomato sauce , salt ,orange juice, lemon swab
- **Method:** 1 drop on tongue
- **Method of evaluation:** Diaphoresis, facial flush, spitting, swallowing
- **Duration :** 3 minutes
- **Response:**
  - No swallow/gag/cough reflex
  - Poor swallow reflex; saliva drools
  - Inability to open mouth
  - Tongue moves food efficiently for swallow
  - Patient eating semi-solids
  - Patient drinking fluids

➢ **FUNCTION: Light touch**

- **Type**
  - Feather or sponge

- Use a variety of textures, such as personal clothing, blankets, stuffed animals, lotions, etc.
- Use a variety of temperatures, such as warm and cold cloths or metal spoons dipped for 30 seconds in hot or cold water

❖ **Method:** Down limbs-first one side, then the other

❖ **Duration:** 30 sec for each item with a total duration of 3 minutes

❖ **Method of evaluation:** Continued until patient can give verbal response

❖ **Response:**

- No response to deep pain
- Withdrawal to painful stimulus
- No response to light touch, pressure, vibration
- Piloerection to cold stimulus
- Withdrawal to cold stimulus

➢ **FUNCTION: Pressure**

❖ **Type**

- Vary the degree of pressure –

  Eg: include grasping a muscle and maintaining the pressure , stretching a tendon and maintaining the stretch for a few seconds, and rubbing the sternum
- Increased pressure against muscles

❖ **Method:** Down limbs-first one side, then the other

❖ **Duration:** 3 seconds

❖ **Method of evaluation:** Continued until patient can give verbal response

❖ **Response:**

- No response to deep pain
- Withdrawal to painful stimulus
- No response to light touch, pressure, vibration

- **FUNCTION: Pain**

  - **Type:** Pressure to TMJ; trapezius muscle; fingernail beds
  - **Method:** Up to 5 sec.
  - **Method of evaluation:** Withdrawal

- **FUNCTION: Range of motion**

  - **Type**
    - Range of motion
    - Alternative movements
  - **Method**
    - ROM to all joints
    - Arms raised alternately
    - Legs raised alternately
    - Use range of motion exercises, changes in body position such as a single or repetitive roll, a tilt table to bring the patient to a more upright position, and movement activities on a therapy mat
  - **Duration:** 5 minutes
  - **Method of evaluation:** Degree of range patient participation

  - **Response:**
    - Flaccidity
    - No voluntary movement
    - Spasticity of joints
    - Moves joint/limb to command
    - Assists with exercises

WARNING SIGNS OF SENSORY OVER LOAD:

- Flushing
- Perspiring
- Prolonged increase in respiration rate

- Agitation
- Closing of eyes
- Sudden decrease in level of arousal
- Increase in muscle tone

In this study olfactory and gustatory stimulation was not given because the patients were on tracheostomy tube.

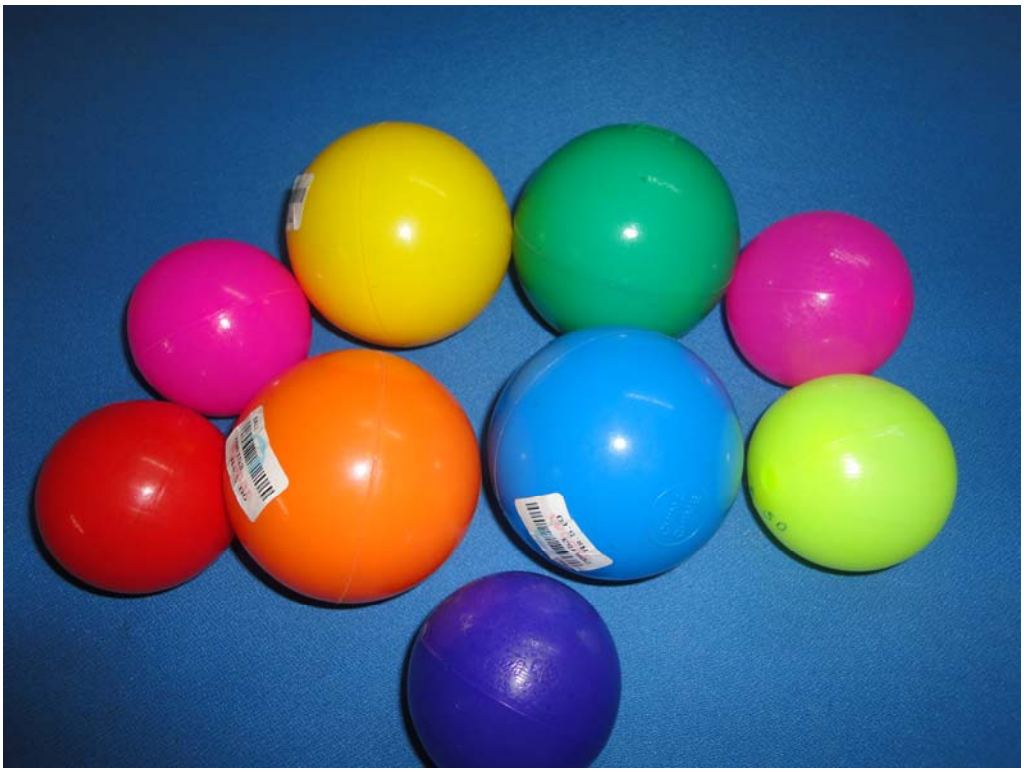


Fig., 1b showing the materails in coma kit used in this study

Fig., 1c, showing the materials in coma kit used in this study

Fig., 1.d, Showing the Placement Of Electrode

4.8 TREATMENT DURATION:

15 sessions for two hours per day for both the groups.

4.9 OUTCOME MEASURES:

1. WESTERN NEURO SENSORY STIMULATION PROFILE (WNSSP)

This scale closely monitors and predicts the change in the slow-to recover patients with head injury. This scale also provides more specific information about on the effective functioning of each cognitive sensory modality is functioning.

Score range is from 1 – 110

Divide into six components:

Arousal attention, auditory response, auditory comprehension, expressive communication, visual tracking, visual comprehension, tactile response, object manipulation and olfactory response.

To assess the minimally conscious state closely follows the developmental and maturational recovery pattern.

2. GLASGOW COMA SCALE (GCS)

It was developed by Teasdale and Jennet, in 1974 in Glasgow to assess the level of consciousness in the acute stage and to classify the severity of trauma. It measures the ocular, verbal motor functions.

Score range is 0 -15

Divided into three components:

1. Eye response
2. Verbal response
3. Motor response

4.10 STATISTICAL ANALYSIS

Pre-test and Post-test values of the study will be collected and assessed for variation in improvement & their results will be analyzed using Independent `t' test and Paired `t' test.

INDEPENDENT `t' TEST (between groups)

$$t - \frac{\overline{X1} - \overline{X2}}{S}\sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where,

$$S = \sqrt{\frac{\Sigma d_1^2 + \Sigma d_2^2}{n_1 + n_2 - 2}}$$

PAIRED `t'TEST (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where,

$$S = \sqrt{\frac{\Sigma d^2 - [\bar{d}]^2 \times n}{n-1}}$$

S=combined standard deviation

$d_1 \& d_2$ =difference between initial & final readings in group A &group B respectively.

$n_1 \& n_2$ =number of patients in group A & group B respectively.

$\overline{X_1} \& \overline{X_2}$ =Mean of group A & group B respectively.

Data analysis and Results

5. DATA ANALYSIS AND RESULTS

5.1 DEMOGRAPHIC DATA

		CONTROL GROUP	EXPERIMENTAL GROUP
AGE [NO OF SUBJECTS]	MALE	4(100)%	5(100)%
NO OF DAYS STAY IN ICU		21.25±5.62	31±16.78

5 .2 TABULAR PRESENTATION

Table: 5.2.1 Paired 't' test value for WNSSP scale among control group

	Pre-test	Post-test
Mean SD	4.0 ± .81	18.75 ± 1.25
Mean Difference	14.7	
Calculated 'T' value	30.812	
P value and level of significance	P < 0.05 and significant	

Table: 5.2.2 Paired 't' test value for Western Neuro Sensory Stimulation Profile scale among experimental group

	Pre-test	Post-test
Mean SD	4.6 ± 1.81	20.4 ± 4.82
Mean Difference	15.8	
Calculated 'T' value	11.648	
P value and level of significance	P < 0.05 and significant	

Table: 5.2.3 Paired 't' test value for Glasgow Coma Scale among control group

	Pre-test	Post-test
Mean SD	3.5 ± .57	6.5 ± .57
Mean Difference	3.0	
Calculated 'T' value	7.348	
P value and level of significance	P < 0.05 and significant	

5.2.4 Paired 't' test value for Glasgow Coma Scale among experimental group

	Pre-test	Post-test
Mean SD	3.8 ± .83	7.6 ± .54
Mean Difference	3.8	
Calculated 'T' value	10.156	
P value and level of significance	P < 0.05 and significant	

5.2.5 Independent 't' test value of pre-test for Western Neuro Sensory Stimulation Profile scale between experimental and control group

	Experimental group	Control group
Mean SD	4.6 ± 1.81	4.0 ± .81
Mean Difference	.6	
Calculated 'T' value	.607	
P value and level of significance	P > 0.05 and not significant	

5.2.6 Independent 't' test value of post-test for Western Neuro Sensory Stimulation Profile scale between experimental and control group

	Experimental Group	Control group
Mean SD	20.40 ± 4.8	18.75 ± 1.25
Mean Difference	1.65	
Calculated 'T' value	.658	
P value and level of significance	P > 0.05 and not significant	

5.2.7 Independent 't' test value of pre-test for Glasgow Coma Scale between experimental and control group

	Experimental Group	Control group
Mean SD	3.8 ± .83	3.5 ± .57
Mean Difference	.30	
Calculated 'T' value	.607	
P value and level of significance	P > 0.05 and not significant	

5.2.8 Independent ‘t’ test value of post-test for Glasgow Coma Scale between experimental and control group

	Experimental Group	Control group
Mean SD	7.6 ± .54	6.5 ± .57
Mean Difference	1.1	
Calculated ‘T’ value	2.925	
P value and level of significance	$P < 0.05$ and significant	

5.3. GRAPHICAL REPRESENTATION

Fig. 5.3.1 Graphical representation of mean value for Western Neuro Sensory Stimulation Profile among control group

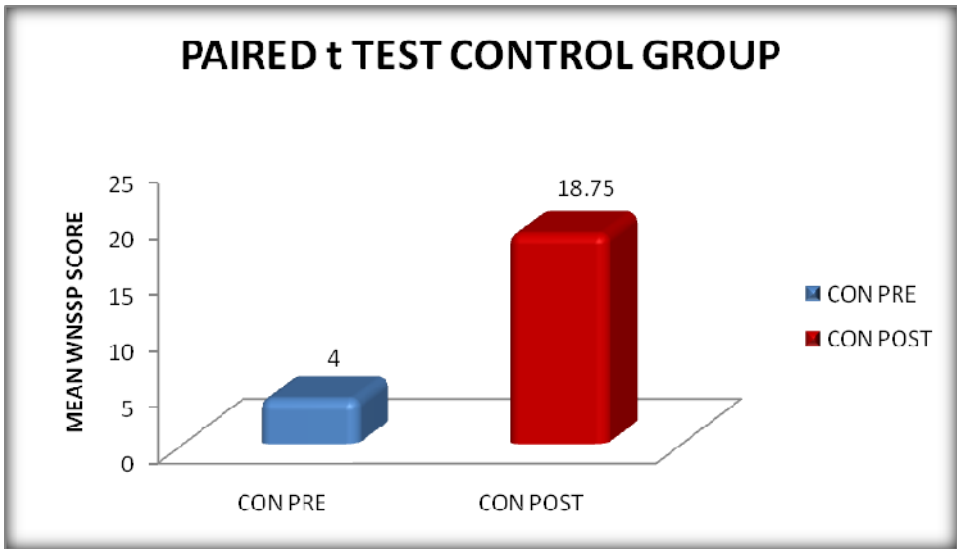


Fig. 5.3.2 Graphical representation of mean value for Western Neuro Sensory Stimulation Profile among experimental group

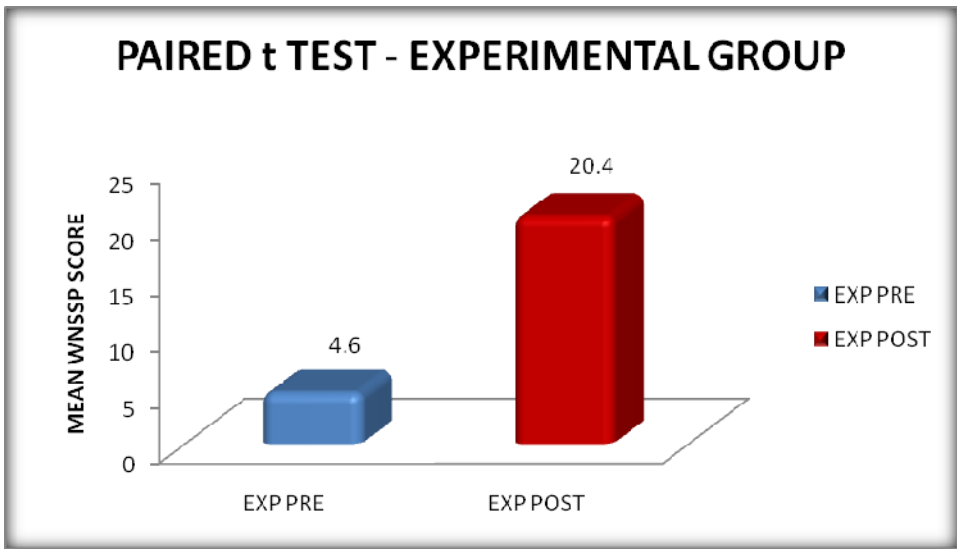


Fig. 5.3.3 Graphical representation of mean value for Glasgow Coma Scale among control group

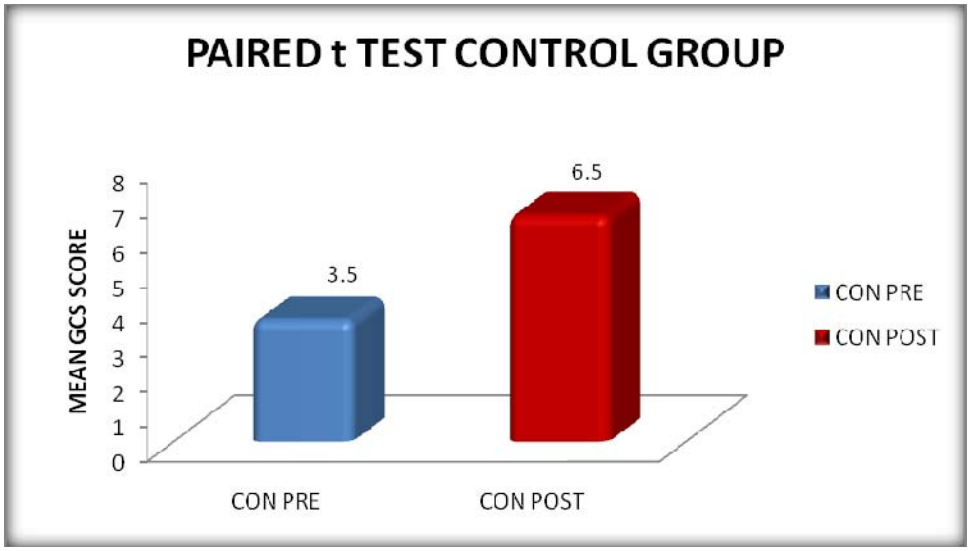


Fig. 5.3.4 Graphical representation of mean value for Glasgow Coma Scale among experimental group

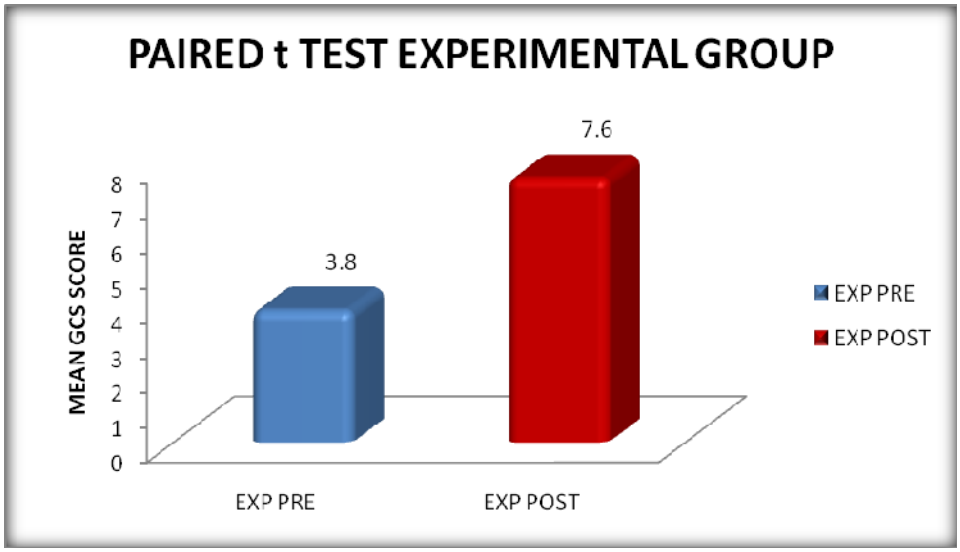


Fig. 5.3.5 Graphical representation of mean value of pre-test for Western Neuro Sensory Stimulation Profile between experimental and control group

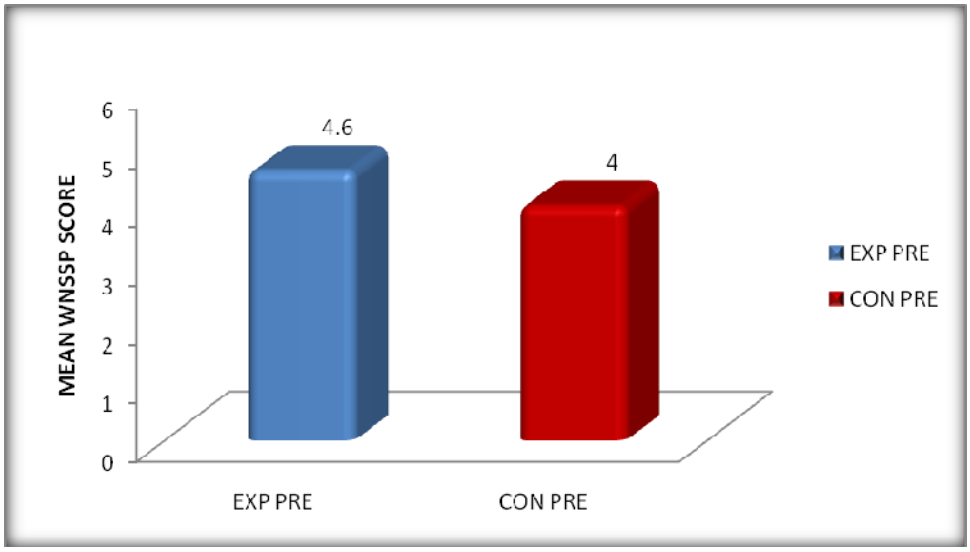


Fig. 5.3.6 Graphical representation of mean value of post-test for Western Neuro Sensory Stimulation Profile between experimental and control group

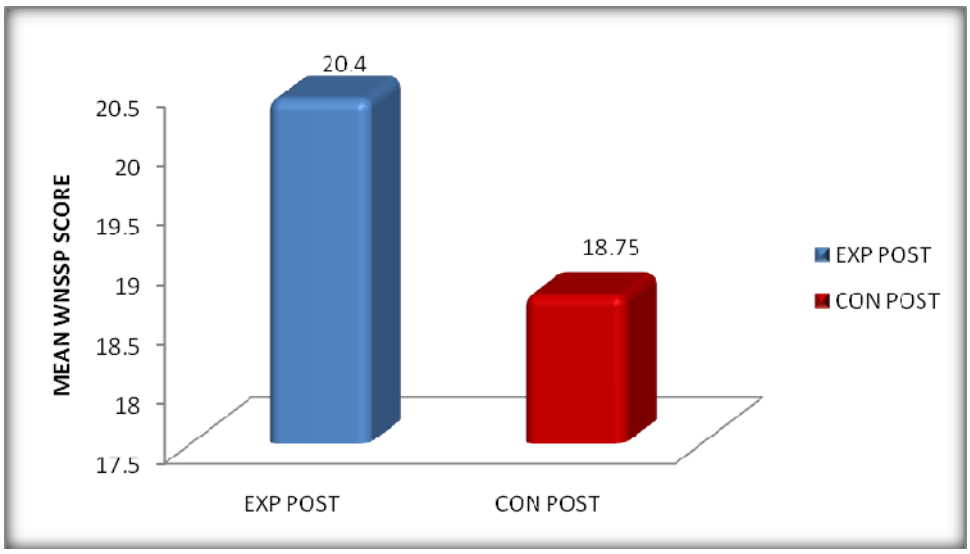


Fig. 5.3.7 Graphical representation of mean value of pre-test for Glasgow Coma Scale between experimental and control group

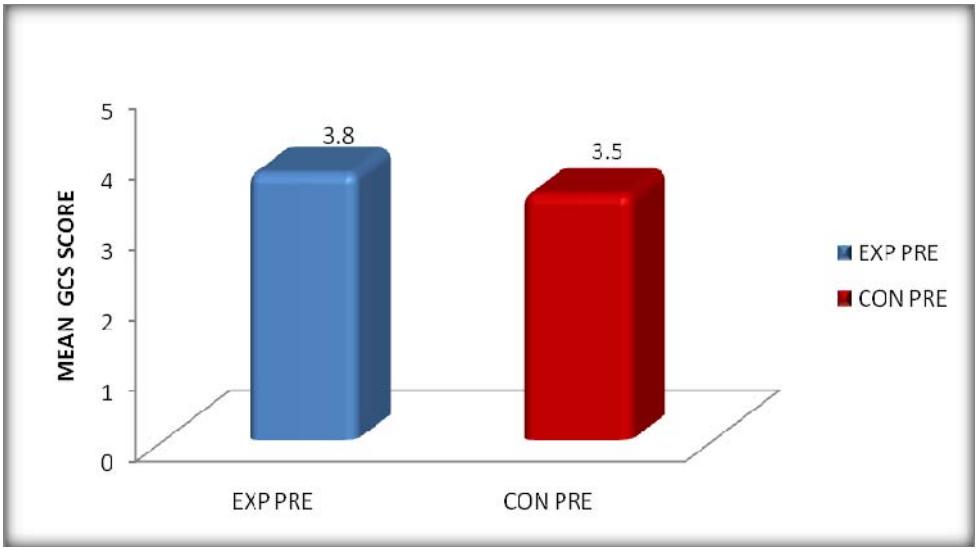
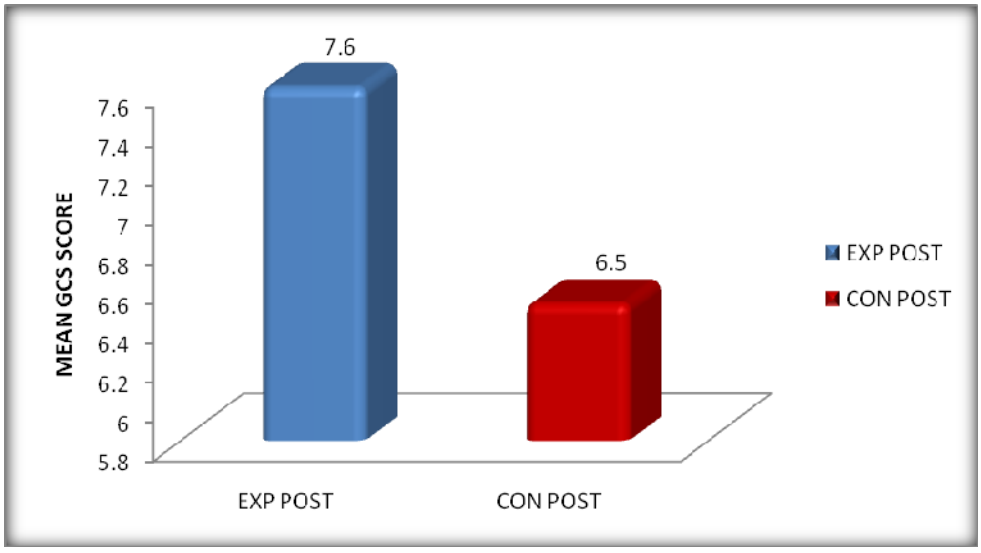


Fig. 5.3.8 Graphical representation of mean value of post-test for Glasgow Coma Scale between experimental and control group



5.4. RESULTS:

Paired 't' test value for Western Neuro Sensory Stimulation Profile scale among control group:

As shown in table, 5.2.1, the mean value of pre test and post test are 4.0 and 18.7 respectively. The calculated 't' value is 30.8 at 3 degrees of freedom at 5% level of significance. Since the calculated value is greater than table value, the alternate hypothesis (H_{a2}) is accepted. Thus, there is a significant improvement in neuro behavioural function in sham stimulation along with multi structural sensory stimulation patients.

Paired 't' test value for Western Neuro Sensory Stimulation Profile scale among experimental group:

As shown in table, 5.2.2, The mean value of pre test and post test are 4.6 and 20.4 respectively. The calculated 't' value is 11.648 at 4 degrees of freedom at 5% level of significance. Since the calculated value is greater than table value, the alternate hypothesis (H_{a1}) is accepted. Thus, there is a significant improvement in neuro behavioural function in right side median nerve stimulation along with multi structural sensory stimulation patients.

Paired 't' test value for Glasgow Coma Scale among control group:

As shown in table, 5.2.3, the mean value of pre test and post test are 3.5 and 6.5 respectively. The calculated 't' value is 7.34 at 3 degrees of freedom at 5% level of significance. Since the calculated value is greater than table value, the alternate hypothesis (H_{a2}) is accepted. Thus, there is a significant improvement in level of consciousness in sham stimulation along with multi structural sensory stimulation patients.

Paired 't' test value for Glasgow Coma Scale among experimental group:

As shown in table, 5.2.4, the mean value of pre test and post test are 3.8 and 7.6 respectively. The calculated 't' value is 10.15 at 4 degrees of freedom at 5% level of significance. Since the calculated value is greater than table value, the alternate hypothesis (H_{a1}) is accepted. Thus, there is a significant improvement in level of consciousness in right side median nerve stimulation along with multi structural sensory stimulation patients.

Independent 't' test value for pre-test for Western Neuro Sensory Stimulation Profile scale between experimental and control group:

As shown in table, 5.2.5, the mean value of pre test is 4.6 and 4.0 respectively. The calculated 't' value is .607 at 7 degrees of freedom at 5% level of significance. Since the calculated value is lesser than table value, the null hypothesis (H_{03}) is accepted. Thus, there is a no significant improvement in neurobehavioral function between experimental and control group.

Independent 't' test value for post-test for Western Neuro Sensory Stimulation Profile scale between experimental and control group:

As shown in table, 5.2.6, the mean value of post test is 20.4 and 18.75 respectively. The calculated 't' value is .658 at 7 degrees of freedom at 5% level of significance. Since the calculated value is lesser than table value, the null hypothesis (H_{03}) is accepted. Thus, there is a no significant improvement in neurobehavioral function between experimental and control group.

Independent 't' test value for pre-test for Glasgow Coma Scale between experimental and control group:

As shown in table, 5.2.7, the mean value of pre test is 3.8 and 3.5 respectively. The calculated 't' value is .607 at 7 degrees of freedom at 5% level of significance. Since the calculated value is lesser than table value, the null hypothesis (H_{03}) is accepted. Thus, there is a no significant improvement in level of consciousness between experimental and control group.

Independent 't' test value for post-test for Glasgow Coma Scale between experimental and control group:

As shown in table, 5.2.8, the mean value of post test is 7.6 and 6.5 respectively. The calculated 't' value is 2.925 at 7 degrees of freedom at 5% level of significance. Since the calculated value is higher than table value, the alternate hypothesis (H_{a3}) is accepted. Thus, there is a significant improvement in level of consciousness between experimental and control group.

Discussion

6. DISCUSSION

Following coma the ability for responding to both the external and internal stimulus is been altered there is a domination of sensory deprivation (Davis and white 1995). This causes high threshold stimuli to activate the reticular activating system. There are various theories addressing how the brain recovers following any form of brain injury with its apparent adaptability. Of these the Spare Capacity and Reorganization theory states that many parts of brain are non-active or "spare", so that when there is a insult or damage to another part of brain this "spare" area assumes the functions of the damaged area. This restricts the potential loss of function by compensation. As per the redundancy theory there is duplication of the neural pathways and when one pathway is damaged the other pathway will take over the function of the damaged one, and it is also believed that new structure tends to duplicate the old structures and its functions, therefore there is no need to devise different functions. The Response at Cellular Level Theory states that the undamaged axons of neurons around the dead area give new connections attempting to rewire the damages system. This process of "collateral sprouting" compensates the brain's inability to grow new cells. Referring to the Environmental Effects Theory there exists a improved performance whenever there is a increase in environmental stimulation.

Coma arousal therapy aims at achieving wakefulness in patients and "arousing" a person from coma. This is achieved by attaining the above said "Collateral Sprouting" by utilizing controlled stimulation which meets the higher threshold of activating reticular neurons and increasing cortical activity. This study also shows that the control group had improved in conscious level. The findings are supported by the researches of Mitchell et al (1990) that patients in the group receiving coma arousal therapy showed faster improvements in consciousness; Oh and Seo (2003) that conscious level improved within 2 weeks following a SSP respectively.

Median nerve is being considered as a peripheral gateway to the central nervous system. Hand has a larger sensory distribution in cortical representation. The spinoreticular component of the median nerve synapses with the neurons of the Ascending Reticular Activating System. Nor epinephrine is released by the nearby Locus coeruleus which causes a

monoaminergic arousal of the cortex directed to cortical layer - I. Acetylcholine input from the Ascending Reticular Activating System activates the intralaminar nucleus of thalamus. Nonspecific excitatory input to cortical layer - I is provided by the intralaminar thalamic nuclei which in part responsible for initiation of awakening. Forebrain basal nucleus of meynert is responsible for diffusely delivering acetylcholine to the cortex after being activated by the excited Ascending Reticular Activating System.

In this study the right median nerve was chosen because of suggestion by the previous authors who stated that it as a portal to stimulate the brainstem and cerebrum because of increased alertness and speech following Right Median Nerve Stimulation. Broca's motor speech planning area in left front temporal region shown to become more effective when a subject moves or even contemplates moving his/her hand in PET. The same is shown with Right Median Nerve Stimulation.

The present study was carried out with 9 participants. The experimental group (n=5) underwent continuous right median nerve electrical stimulation for one hour followed by one hour of structured multi sensory coma stimulation. The control group (n=4) received structured multi sensory coma stimulation for one hour followed by sham stimulation for one hour. The level of consciousness was assessed with Glasgow Coma Scale and the Western Neuro Sensory Stimulation Profile was used to assess the individual sensory system alertness before and after the study. The data analyses were carried out with 't' test.

The paired 't' test results show that both the control and experimental group had a significant improvement in Level of Consciousness by using Glasgow Coma Scale and also in Neurobehavioral Function by using Western Neuro Sensory Stimulation Profile scale. The independent 't' test values for post test between the groups showed that there is no significant difference in Neurobehavioral Function but there exists a significant difference in Level Of Consciousness. But when comparing the post test mean values of both the groups the experimental group shows a better clinical improvement in the Neurobehavioral Function than the control group.

Though previous authors found that Right Median Nerve Stimulation is significantly effective in improving Level of Consciousness when compared with sham and control group

this study shows statistical significant improvement in Level of Consciousness alone and failed to show statistical significant improvement in Neurobehavioral Function. The reason may be attributed such that in previous studies the duration of stimulation was higher which is about 8 hours. But in this study stimulation duration was only for 1 hour. Another major contributing factor is that olfactory and comprehension component of the Western.

Neuro sensory Stimulation Profile was not assessable because all of the patients were in an acute state, so they were unable to sense or respond to the external stimuli and also tracheostimized (artificially ventilated with a tracheostomy tube). Also most of the study had mixed sample involving Traumatic Brain Injury, Ischemic Hypoxic Encephalopathy, Diffuse Axonal Injury, Encephalopathy following cardiopulmonary resuscitation and most of the studies were also single case studies and pilot studies. Most of the previous studies have quantifiable outcome measures such as Single Photon Emission Computerized Tomography, Electroencephalogram, and Cerebrospinal Fluid analysis. And also in previous studies the outcome measures was taken after 3 months following injury but the present study is focused on finding the immediate outcome (two weeks). And all these may be the reasons why a quantifiable improvement in Neurobehavioral Function was not achieved.

But we got a significant improvement in Level of Consciousness for the post test values between both the groups this can explained on the basis that Glasgow Coma Scale is only a 15 point ordinal scale which primarily measures the 3 responses namely motor, verbal and eye opening. This only measures the severity of injury and directly implies the level of consciousness. The Western Neuro Sensory Stimulation Profile Scale is a 110 point ordinal scale which measures the following 5 components visual, tactile, olfactory, auditory, expressive communication. Since this scale measures in depth analysis of various Neurobehavioral Functions compared to that of Glasgow Coma Scale and most of these functions cannot have a major improvement within the available two weeks and even when there is a change it might not be sufficient to reflect change in Western Neuro Sensory Stimulation Profile Scale. This may be the reason why the Western Neuro Sensory Stimulation Profile Scale failed to show statistically significant improvement although the post test mean values were higher for experimental group than the control group. And also in a study it has been stated that Western Neuro Sensory Stimulation Profile scale is reliable in

patients with moderate to minimal Disorders of Consciousness. But most of the cases in the present study were severe Traumatic Brain Injury patients.

Summary and conclusion

7. SUMMARY AND CONCLUSION

The present study was intended to find out the effect of right median nerve stimulation along with structured multi sensory coma stimulation program on level of consciousness and the neurobehavioral function among diffuse axonal injury patients.

The results showed that there was a significant improvement in Level of Consciousness between the groups but there was no significant improvement in the Neurobehavioral Functions between the groups.

Limitations and suggestions

8. LIMITATIONS & SUGGESTIONS

LIMITATIONS:

1. The sample size is smaller.
2. Long term follow up was not done.
3. Study was done only on Diffuse Axonal Injury patients with closed head injury.
4. 2 hours treatment session is not adequate.
5. Quantifiable measures such as Functional Magnetic resonance imaging, Single Photon Emission Computerized Tomography , Somatosensory Evoked Potentials were not carried out.

SUGGESTIONS:

1. Future studies can be done on a large sample population based on age; severity of injury; level of consciousness, time of injury and duration of coma.
2. Long term follow-up can be taken to find out the improvement in the neuro behavioural functions.
3. Long treatment duration can be given.
4. Future studies can also be done with non traumatic brain injury patients.
5. Follow up study at 3 months, 6 months and after 1 year can be done.

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Appendices

APPENDIX I

ASSESSMENT FORM

Name: **Age/Sex:**

Occupation:

Address:

History:

- ✓ Has the patient sustained a head injury?
- ✓ Did the patient collapse suddenly?
- ✓ Did the limb twitching occur?
- ✓ Has the patient suffered a previous illness?
- ✓ Does the patient take any medication?
- ✓ Any history of alcohol intake or drug abuse?
- ✓ Mechanism of injury:
- ✓ Previous head injury:
- ✓ Drug history:
- ✓ The patient is on tracheostomy or not?

VITAL SIGNS:

- ✓ Blood pressure:
- ✓ Pulse rate:
- ✓ Respiratory rate:
- ✓ Mode of ventilation:
- ✓ Temperature:
- ✓ Intracranial pressure: (7 – 15 mm/Hg)
- ✓ Mean arterial pressure: (60 to 150 mm/Hg)
- ✓ Cerebral Perfusion Pressure: [(MAP – ICP) (70 – 90 mm/Hg)]

- ✓ CBF: (CPP /CVR)
- ✓ Cerebrospinal fluid value: (100 - 150 ml)

ASSESSMENT OF LEVEL OF CONSCIOUSNESS:

- GCS:

✓ BEST EYE RESPONSE:

1. No eye opening to any stimulation.
2. Eye opening only in response to pain.
3. Eye opening to speech.
4. Eyes are open spontaneously.

✓ BEST VERBAL RESPONSE:

1. No verbal response.
2. Incomprehensible sounds (such as moaning, but not saying words).
3. Inappropriate words (such as random, profanity or exclamatory speech; forms words but not normal in response to conversation).
4. Confused (the patient speaks and answers questions but is confused or disoriented).
5. Oriented (the patient is coherent and appropriate and knows their name, age, date, etc.).

✓ BEST MOTOR RESPONSE:

1. No motor response (no movement, even to painful stimuli).
2. Extension to pain (this is also called decerebrate posturing, it is a specific type of primitive reflex that is seem when higher brain function is significantly impaired but the brain stem is still functioning somewhat).
3. Abnormal flexion to pain (also called, decorticate posturing, another type of primitive reflex which is abnormal).
4. Withdrawal to pain (the patient obviously pulls away the part of the body being stimulated).

5. Localizes to pain (this means that the patient makes purposeful movements toward a painful stimuli, attempting to push away the stimulus).

6. Obeys commands (the patient follows simple commands such as "show me two fingers" or "wiggle your toes").

- **PAIN / NOXIUS STIMULI:**

✓ **CENTRAL STIMULI:**

1. Trapezius squeeze:
2. Supra orbital pressure:
3. Jaw margin pressure:
4. Sternal rub:

✓ **PERIPHERAL STIMULI**:

1. Finger pressure:

- **PUPILARY ASSESSMENT:**

1. Size
2. Shape
3. Reactive to light
4. Comparison of one pupil to the other

INVESTIGATION:

- CT SCAN:

✓Midline shift:

- EEG REPORT:
- EVOKED POTENTIALS:

✓ SSEP:

✓ BSEP:

✓ VEP:

- NERVE CONDUCTION STUDY:

APPENDIX II

INFORMED CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

I _____ voluntarily consent to participate in the research study "**THE EFFECT OF RIGHT SIDE MEDIAN NERVE STIMULATION ALONG WITH STRUCTURED MULTI SENSORY COMA STIMULATION PROGRAM ON LEVEL OF CONSCIOUSNESS AND NEUROBEHAVIORAL FUNCTIONS AMONG DIFFUSE AXONAL INJURY PATIENTS.**".

The researcher has explained me about the research in brief, the risk of participation and has answered the questions related to the research to my satisfaction.

Signature of the caregiver/relative:

Signature of the researcher:

Signature of the witness:

APPENDIX-III

GLASGOW COMA SCALE

Eye Opening Response

- Spontaneous--open with blinking at baseline **4 points**
- To verbal stimuli, command, speech **3 points**
- To pain only (not applied to face) **2 points**
- No response **1 point**

Verbal Response

- Oriented **5 points**
- Confused conversation, but able to answer questions **4 points**
- Inappropriate words **3 points**
- Incomprehensible speech **2 points**
- No response **1 point**

Motor Response

- Obeys commands for movement **6 points**
- Purposeful movement to painful stimulus **5 points**
- Withdraws in response to pain **4 points**
- Flexion in response to pain (decorticate posturing) **3 points**
- Extension response in response to pain (decerebrate posturing) **2 points**
- No response **1 point**

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APPENDIX-IV

WESTERN NEURO SENSORY STIMULATION PROFILE (WNSSP)

I. AROUSAL/ATTENTION

1. Arousability: (eye opening/facial or body movement to voice/touch or shaking/raising bed/wet cloth on face)

0 = Requires REPEATED presentation of two or more stimuli

1 = TWO OR MORE stimuli

2 = ONE stimulus

3 = SPONTANEOUSLY AWAKE

2. Wakefulness: Longest period without being re-aroused

0 = < 10 min

1 = 11-20 min

2 = > 21 min (or all throughout testing session)

3. Eye Contact:

0 = Eyes CLOSED

1 = Eyes OPEN but not focused on examiner

2 = Eyes FOCUSED on examiner (50% or more)

N = Physically unable to open eyes (CN III paralysis)

4. Attention to Task: Visual attention or ability to attend to tasks

0 = Attends <50% of time

1 = Attends >50% of time

II. AUDITORY RESPONSE

LOCALIZATION

5. Voice: Response to introductory remarks: “Hello my name is …”

0 = NO response < 20 s

1 = UNDIFFERENTIATED (does not awaken and than = to all stimuli: posturing, hyperventilation, chewing)

2 = DIFFERENTIATED (awakens or ≠ to various stimuli: eye movement/head turn)

6. Sound: Best response to non-verbal sound (music/bell/clicker/tape recorder/sneeze/door slam …out of visual field)

0 = NO response < 20 s

1 = UNDIFFERENTIATED (= to all stimuli: posturing, hyperventilation, blinking, chewing,)

2 = DIFFERENTIATED (≠ to various stimuli: eye movement/head turn, movement of part touched or named)

COMPREHENSION (of single-stage auditory commands, repeat once without penalty than use ≠ cues, score only coinciding responses, penalty for perseveration)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

7. Shake my hand

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

8. Open/close mouth (if mouth is usually closed, use "open" for command)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

9. Stick out tongue

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

10. Close/open eyes (if eyes are usually opened, use "closed" for command)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

11. Raise eyebrows

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

12. Move body part (that patient can move spontaneously)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching /moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

III.EXPRESSIVE COMMUNICATION

13. Vocalization:

0 = NO response

1 = Best spontaneous, non-meaningful VOCALIZATION (moaning, sighing, crying, other vocal noises)

2 = Best spontaneous, INAPPROPRIATE VERBALIZATION or mouthing of words irrelevant to the stimulus or unintelligible)

3 = Vocalizes on COMMAND (repetition of sound or word) or mouths words or verbalizes APPROPRIATELY either spontaneously or on command (intelligible, relevant speech)

14. Facial/Gestural expression for communication: (except for yes/no head nods)

0 = No response during the entire session (only RANDOM grimaces/reflex or involuntary behaviors)

1 = ONE (smiling/frowning/eyebrow/eye widening/pointing/reaching/shoulders/waving/pushing away)

2 = Uses > ONE gesture/facial expression with communicative intent

15. Yes/No Response: verbal or nonverbal (finger signals, eye gaze, buzzer system) to 3 verbal or written questions spontaneous responses may be given credit (Are you married?/Do you live in/ Were you born in the year…)

0 = NEITHER response observed

1 = Either "Yes" OR "No" response observed (does not need to be accurate, only present)

2 = BOTH responses observed (does not need to be accurate, only present)

IV. VISUAL RESPONSE

TRACKING (repeat several times)

Horizontal Tracking:

0 = NO response < 20 s

1 = Follows (from midline) to left OR right side

2 = Follows (from midline) to left AND right side

3 = Follows across midline from one side to the other

16. Horizontal mirror

0 = NO response < 20 s

1 = Follows (from midline) to left OR right side

2 = Follows (from midline) to left AND right side

3 = Follows across midline from one side to the other

17. Horizontal individual (slowly walk from one side of bed/chair around to opposite side, examiner or other person)

0 = NO response < 20 s

1 = Follows (from midline) to left OR right side

2 = Follows (from midline) to left AND right side

3 = Follows across midline from one side to the other

18. Horizontal picture (large, brightly colored familiar personality/greeting card/family picture)

0 = NO response < 20 s

1 = Follows (from midline) to left OR right side

2 = Follows (from midline) to left AND right side

3 = Follows across midline from one side to the other

19. Horizontal object (no-sound producing, brightly colored puppet/snow globe with moving parts)

0 = NO response < 20 s

1 = Follows (from midline) to left OR right side

2 = Follows (from midline) to left AND right side

3 = Follows across midline from one side to the other

20. Horizontal mirror

Vertical tracking:

0 = NO response < 20 s

1 = Follows (from midline) up OR down

2 = Follows (from midline) up AND down

21. Vertical picture

0 = NO response < 20 s

1 = Follows (from midline) up OR down

2 = Follows (from midline) up AND down

22. Vertical object

0 = NO response < 20 s

1 = Follows (from midline) up OR down

2 = Follows (from midline) up AND down

COMPREHENSION: Best response to single-stage written commands, "Read card & do what

it says", direction may be repeated once & attention directed to card by pointing without penalty, than use ≠ cues. Do not read card

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

23. Open mouth (if mouth is usually closed, use "open" for command)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

24. Stick out tongue

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

25. Close eyes (if eyes are usually opened, use "closed" for command)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

26. Raise eyebrows

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

27. Move body part (that patient can move spontaneously)

0 = NO response < 20 s

1 = Incorrect response

2 = Cued (prior visual modeling /touching or moving intended body part) delayed (>5 s) response

3 = Cued, prompt response

4 = Spontaneous, delayed response (response after more than 5 s)

5 = Spontaneous, prompt response

V. TACTILE RESPONSE

LOCALIZATION

28. Touch: (non-painful tap on shoulder outside vision/ stimulation of ≠ body parts with brush, rough towel, comb)

0 = NO response < 20 s

1 = UNDIFFERENTIATED (= to all stimuli: reflexive posturing, hyperventilation, blinking, chewing,)

2 = DIFFERENTIATED (≠ to various stimuli: eye movement/head turn, movement of part touched or named)

29. Oral Stimulation: (stimulate external surface upper and lower lips with Q-tip)

0 = WITHDRAWAL/ABNORMAL reflexes (tonic bite, tongue or jaw thrust, lip retraction or pursing)

1 = PRIMITIVE REFLEXES (chewing, sucking, phasic bite, rooting)

2 = TOLERATES stimulation

OBJECT MANIPULATION ("This is a -. Show me how you use it")

0 = No response < 20 s

1 = Holds/releases object

2 = Moves object/uses it inappropriately

3 = Reaches for/pushes away object

4 = Uses appropriately cued (demonstrate correct use, help initiate by touching/raising arm)

5 = Uses appropriately spontaneously

N = Both arms casted or splinted

30. Manipulation spoon (present in field of vision or in hand if unable to take it)

0 = No response < 20 s

1 = Holds/releases object

2 = Moves object/uses it inappropriately

3 = Reaches for/pushes away object

4 = Uses appropriately cued (demonstrate correct use, help initiate by touching/raising arm)

5 = Uses appropriately spontaneously

N = Both arms casted or splinted

31. Manipulation comb (if score <3 thought related to motor rather than cognitive limitations circle the score)

0 = No response < 20 s

1 = Holds/releases object

2 = Moves object/uses it inappropriately

3 = Reaches for/pushes away object

4 = Uses appropriately cued (demonstrate correct use, help initiate by touching/raising arm)

5 = Uses appropriately spontaneously

N = Both arms casted or splinted

32. Manipulation pencil (try to elicit understanding of object's use by alternate means such as yes/no questions)

0 = No response < 20 s

1 = Holds/releases object

2 = Moves object/uses it inappropriately

3 = Reaches for/pushes away object

4 = Uses appropriately cued (demonstrate correct use, help initiate by touching/raising arm)

5 = Uses appropriately spontaneously

N = Both arms casted or splinted

VI OLFACTORY RESPONSE

(pleasant and unpleasant: cologne/foods: vinegar, cinnamon,
coffee, and garlic , etc)

0 = No response < 20 s

1 = UNDIFFERENTIATED (= to all stimuli: reflexive posturing, hyperventilation, blinking, chewing,)

2 = DIFFERENTIATED (≠ to various stimuli: eye movement/head turn, movement of part touched or named)

N = Not applicable (tracheostomy).